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**January 1997**



***Chemistry 30***  
***Grade 12 Diploma Examination***

**Alberta**  
EDUCATION

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January 1997

# Chemistry 30

## Grade 12 Diploma Examination

### Description

Time: 2.5 h. You may take an additional 0.5 h to complete the examination.

This is a **closed-book** examination consisting of

- 44 multiple-choice and 12 numerical-response questions, of equal value, worth 70% of the examination
- 2 written-response questions, each worth 15% of the examination

This examination contains sets of related questions

A set of questions may contain multiple-choice and/or numerical-response and/or written-response questions.

When required, a grey bar is used to indicate the end of a set.

A chemistry data booklet is provided for your reference.

The perforated pages at the back of this booklet may be torn out and used for your rough work. No marks will be given for work done on the tear-out pages.

### Instructions

- Fill in the information required on the answer sheet and the examination booklet as directed by the presiding examiner.
- You are expected to provide your own scientific calculator.
- Use only an HB pencil for the machine-scored answer sheet.
- If you wish to change an answer, erase **all** traces of your first answer.
- Consider all numbers used in the examination to be the result of a measurement or observation.
- Do not fold the answer sheet.
- The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Education.
- Read each question carefully.
- Now turn this page and read the detailed instructions for answering machine-scored and written-response questions.

### Multiple Choice

- Decide which of the choices **best** completes the statement or answers the question.
- Locate that question number on the separate answer sheet provided and fill in the circle that corresponds to your choice.

### Example

This examination is for the subject of

- A.** chemistry  
**B.** biology  
**C.** physics  
**D.** science

# Answer Sheet

☒ (A)    ☐ (B)    ☐ (C)    ☐ (D)

### Numerical Response

- Record your answer on the answer sheet provided by writing it in the boxes and then filling in the corresponding circles.
- If an answer is a value between 0 and 1 (e.g., 0.25), then be sure to record the 0 before the decimal place.
- **Enter the first digit of your answer in the left-hand box and leave any unused boxes blank.**

### Examples

### Calculation Question and Solution

The average of the values 21.0, 25.5, and 24.5 is \_\_\_\_\_.

(Record your answer to three digits on the answer sheet.)

$$\begin{aligned}\text{Average} &= (21.0 + 25.5 + 24.5)/3 \\ &= 23.666 \\ &= 23.7 \text{ (rounded to three digits)}\end{aligned}$$

**Record 23.7 on the answer sheet —**

2	3	.	7
	•	●	
0	0	0	0
1	1	1	1
●	2	2	2
3	●	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	●
8	8	8	8
9	9	9	9

### Correct-order Question and Solution

When the following subjects are arranged in alphabetical order, the order is \_\_\_\_\_.  
(Record all four digits on the answer sheet.)

- 1 physics
- 2 chemistry
- 3 biology
- 4 science

Answer 3214

Record 3214 on the  
answer sheet

→ 

3	2	1	4
---	---	---	---

•	•		
0	0	0	0
1	1	●	1
2	●	2	2
●	3	3	3
4	4	4	●
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

### Written Response

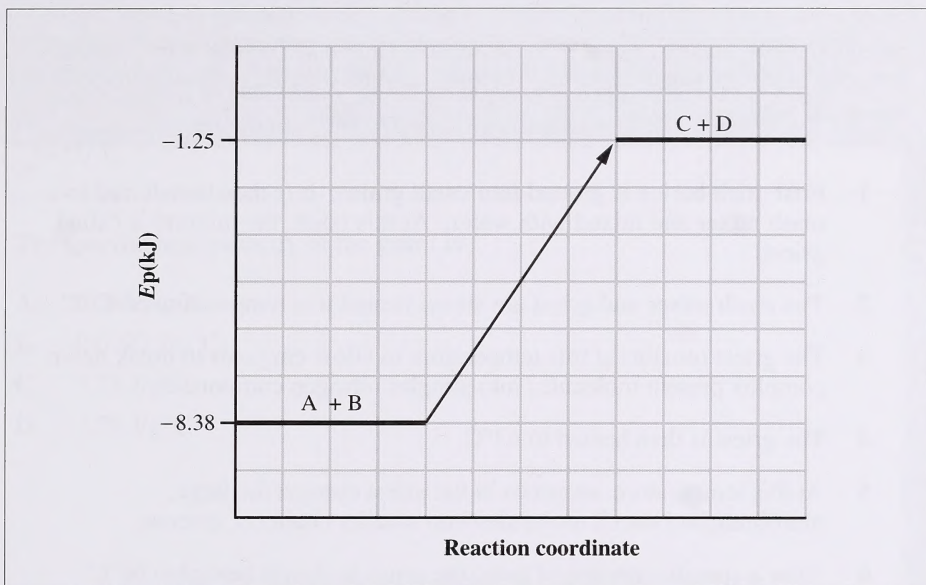
- Write your answers in the examination booklet as neatly as possible.
- For full marks, your answers must be well organized and address **all** the main points of the question.
- Relevant scientific, technological, and/or societal concepts and examples must be identified and made explicit.
- Description and/or explanations of concepts must be correct and reflect pertinent ideas, calculations, and formulas.
- Your answers **should be** presented in a well-organized manner using complete sentences, correct units, and significant digits where appropriate.





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Use the following information to answer the next question.



### Numerical Response

1. The heat of reaction is \_\_\_\_\_ kJ.

(Record your answer to three digits on the answer sheet.)

Beer making is a complicated, multistep process. Beer making depends on the metabolism of sugar by yeast. The process is known as fermentation. When yeast metabolizes sugar molecules, alcohol, carbon dioxide, and other byproducts are produced.

- 1 First, malt barley is ground into small grains. It is then transferred to a mash mixer and mixed with water. At this point, the mixture is called griest.
- 2 The mash mixer and griest are steam-heated to a temperature of  $43^{\circ}\text{C}$ .
- 3 The griest remains at this temperature to allow enzymes to break down complex protein molecules into simpler nitrogen compounds.
- 4 The griest is then heated to  $63^{\circ}\text{C}$ .
- 5 At this temperature, enzymes in the griest convert the large, multibranched starch molecules into smaller chains of glucose.
- 6 After a specific amount of time, the griest is slowly heated to  $68^{\circ}\text{C}$ .
- 7 A different enzyme breaks down the small glucose chains into monosaccharides and disaccharides. The longer the griest remains at this temperature, the more alcohol is produced by the yeast.
- 8 Finally, the temperature is increased to  $77^{\circ}\text{C}$  to stop the enzyme action in the griest.

### Numerical Response

2. Identify which four of the steps involve a kinetic energy change in the griest. Place the corresponding numbers in numerical order on the answer sheet.

(Record all four digits on the answer sheet.)



*Use the following information to answer this question.*

One major cost in the brewing industry is the cost of energy used in running a plant. Much of the heating in a plant is accomplished by the cooling and/or condensing of steam. When 50.0 Mg of griest is heated from 25.0°C to 43.1°C, the temperature of 560 Mg of steam decreases from 120.0°C to 117.0°C.

1. The specific heat capacity of the griest is

- A. 0.268 J/g°C
  - B. 0.0297 J/g°C
  - C. 3.73 J/g°C
  - D. 7.78 J/g°C
- 

*Use the following information to answer this question.*

A boiler, fuelled by natural gas, is used to heat 560 Mg steam up to 120.0°C from 117.0°C. The steam is then circulated throughout a brewery.

### **Numerical Response**

3. If natural gas has a molar heat of combustion of 815.2 kJ/mol and an average molar mass of 16.53 g/mol, then the mass of natural gas required to heat the steam is \_\_\_\_\_ kg.

(Record your answer to three digits on the answer sheet.)

Use the following information to answer the next question.

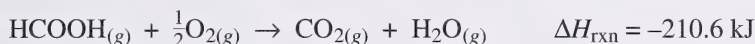
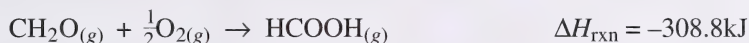
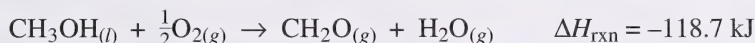
- I. Production of thermal energy
- II. Production of  $\text{CO}_{2(g)}$
- III. Consumption of  $\text{O}_{2(g)}$
- IV. Consumption of  $\text{H}_2\text{O}_{(g)}$

2. Combustion of fossil fuels in a steam plant and cellular respiration are similar in terms of
- A. I, II, IV
  - B. I, II, III
  - C. I, III, IV
  - D. II, III, IV
- 
3. The original source of the energy stored in fossil fuels, such as natural gas, comes from
- A. plants
  - B. animals
  - C. bacteria
  - D. the Sun
4. Burning fossil fuels is often harmful to the environment. Which of the following is **not** a problem associated with the burning of coal or hydrocarbons?
- A. Burning carbon or carbon compounds produces greenhouse gases.
  - B. Coal often contains sulphur, which burns along with the coal-producing  $\text{SO}_{2(g)}$  and acid rain.
  - C. Coal and hydrocarbons are non-renewable resources.
  - D. Burning hydrocarbons produces chlorofluorocarbons that damage the ozone layer.

5. A student obtained an experimental value of  $-44.0$  kJ/mol for the condensation of steam rather than  $-40.8$  kJ/mol. The percentage of error is
- A. 0.927%  
B. 1.08%  
C. 7.27%  
D. 7.84%

*Use the following information to answer the next question.*

Scientists have proposed that the burning of methane involves a four-step reaction pathway.



6. The enthalpy change for the reaction  $\text{CH}_3\text{OH}(\text{l}) + \text{O}_{2(\text{g})} \rightarrow \text{HCOOH}(\text{g}) + \text{H}_2\text{O}(\text{g})$  is
- A.  $\Delta H_{\text{rxn}} = -427.5$  kJ  
B.  $\Delta H_{\text{rxn}} = +190.1$  kJ  
C.  $\Delta H_{\text{rxn}} = -190.1$  kJ  
D.  $\Delta H_{\text{rxn}} = +427.5$  kJ

### Numerical Response

4. The amount of energy involved in increasing the temperature of 2.00 kg of  $\text{H}_2\text{O}(\text{l})$  by  $3.89^\circ\text{C}$  is \_\_\_\_\_ kJ.

(Record your answer to three digits on the answer sheet.)

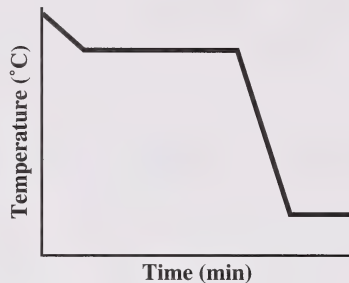


7. A sample of molten iron at 2000°C is poured into a mould and the iron is removed from the mould at room temperature. The diagram that correctly represents temperature changes of the iron is

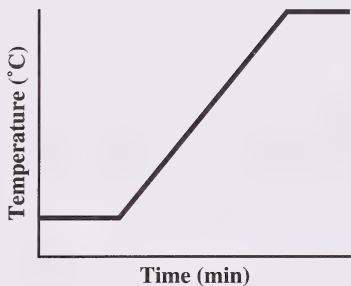
A.



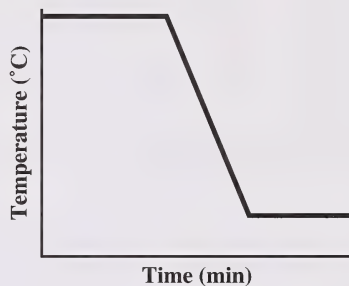
B.



C.



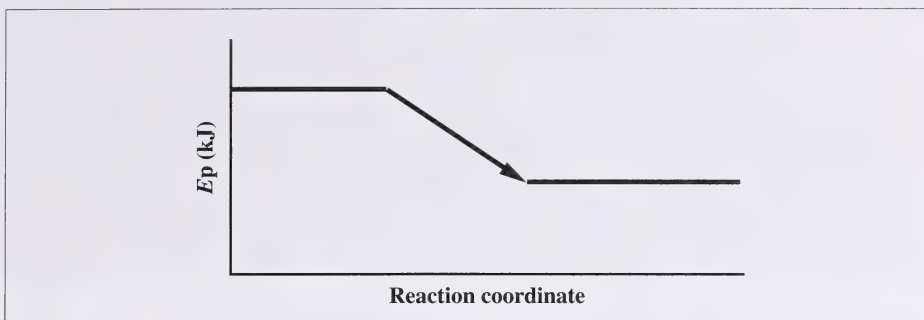
D.



8. An exothermic heat of a reaction can be expressed by writing it

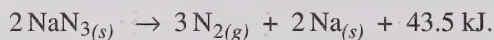
- A. as a positive in  $\Delta H$  notation
- B. on the product side of an equation
- C. on the reactant side of an equation
- D. as a negative value on the product side in the equation

Use the following graph to answer the next question.



9. The graph could represent the formation of all the hydrogen halide compounds from their elements **except** for
- A.  $\text{HI}_{(g)}$
  - B.  $\text{HF}_{(g)}$
  - C.  $\text{HCl}_{(g)}$
  - D.  $\text{HBr}_{(g)}$
- 
10. Which of the following reactions would produce the greatest enthalpy change?
- A.  $\text{H}_2\text{O}_{(l)} \rightarrow \text{H}_2\text{O}_{(g)}$
  - B.  $2 {}^2_1\text{H} \rightarrow {}^4_2\text{He}$
  - C.  $\text{H}_{2(g)} + \frac{1}{2} \text{O}_{2(g)} \rightarrow \text{H}_2\text{O}_{(g)}$
  - D.  $2 \text{KCl}_{(aq)} + \text{Pb}(\text{NO}_3)_{2(aq)} \rightarrow 2 \text{KNO}_{3(aq)} + \text{PbCl}_{2(s)}$
11. A sample of warm water evaporates more rapidly than a sample of cold water because the warm water molecules have more
- A. potential energy, and evaporation is an endothermic process
  - B. potential energy, and evaporation is an exothermic process
  - C. kinetic energy, and evaporation is an endothermic process
  - D. kinetic energy, and evaporation is an exothermic process

Air bags are designed to deploy when a car moving in excess of 18 km/h undergoes a sudden decrease in speed. During the deceleration, an electrical circuit ignites a small amount of explosive powder to cause sodium azide,  $\text{NaN}_{3(s)}$ , to react inside the air bag. The sodium azide rapidly decomposes, producing nitrogen gas, which fills the bag. The equation for this reaction is



12. The molar heat of formation of sodium azide is

- A.  $-43.5 \text{ kJ/mol}$
- B.  $-21.8 \text{ kJ/mol}$
- C.  $+21.8 \text{ kJ/mol}$
- D.  $+43.5 \text{ kJ/mol}$

Use the value selected for **Multiple Choice 12** to answer **Numerical Response 5**.

**Numerical Response**

5. The amount of energy involved when 100 g of  $\text{NaN}_{3(s)}$  decomposes is \_\_\_\_\_ kJ.  
(Record your answer to three digits on the answer sheet.)

13. During the decomposition of sodium azide, the nitrogen

- A. gains electrons and is reduced
- B. gains electrons and is oxidized
- C. loses electrons and is oxidized
- D. loses electrons and is reduced



14. Assume that an inflated air bag contains 169 L of  $\text{N}_{2(g)}$  at  $25.0^{\circ}\text{C}$  and 485 kPa. What mass of sodium azide is required to produce this amount of nitrogen?
- A. 1.43 kg
  - B. 2.15 kg
  - C. 3.23 kg
  - D. 17.1 kg
15. One problem associated with inflated air bags is that a white powder is produced. It can cause skin and eye irritation. This irritation is **most likely** due to the sodium metal reacting with moisture in the surroundings to form
- A. an acid
  - B. a base
  - C. a salt
  - D. an inert, gritty material
- 
16. Increasingly in many industries, chemical byproducts that were once considered wastes that had to be disposed of are now sold to other chemical industries. This change in business practice illustrates a solution to a problem that is driven **mainly** by ecological and
- A. scientific considerations
  - B. technological considerations
  - C. economic considerations
  - D. ethical considerations

Use the following information to answer the next question.

A voltaic cell is constructed using a  $\text{Ag}_{(s)} / \text{Ag}^+_{(aq)}$  half-cell connected to a  $\text{C}_{(s)} / \text{Cr}_2\text{O}_7^{2-}_{(aq)}, \text{H}^+_{(aq)}$  half-cell.

17. The net reaction for the cell is

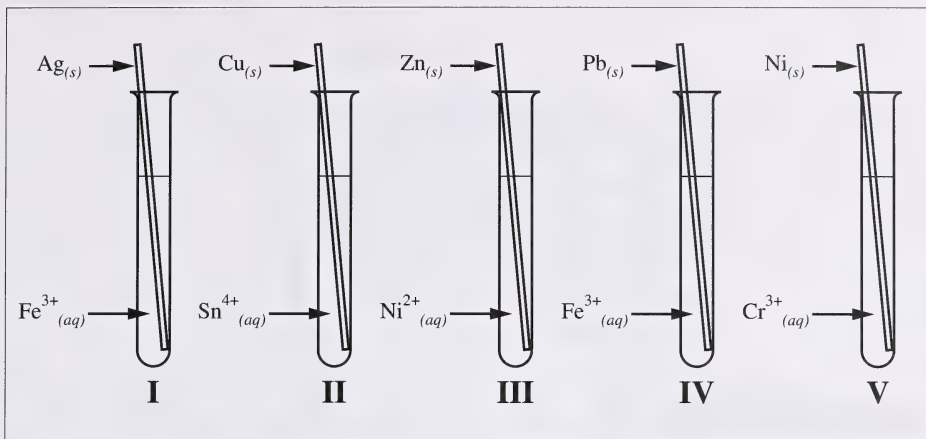
- A.  $3\text{Ag}^+_{(aq)} + \text{Cr}_2\text{O}_7^{2-}_{(aq)} + 14\text{H}^+_{(aq)} \rightarrow 3\text{Ag}_{(s)} + 2\text{Cr}^{3+}_{(aq)} + 7\text{H}_2\text{O}_{(l)}$   
B.  $3\text{Ag}_{(s)} + \text{Cr}_2\text{O}_7^{2-}_{(aq)} + 14\text{H}^+_{(aq)} \rightarrow 3\text{Ag}^+_{(aq)} + 2\text{Cr}^{3+}_{(aq)} + 7\text{H}_2\text{O}_{(l)}$   
C.  $6\text{Ag}^+_{(aq)} + \text{Cr}_2\text{O}_7^{2-}_{(aq)} + 14\text{H}^+_{(aq)} \rightarrow 6\text{Ag}_{(s)} + 2\text{Cr}^{3+}_{(aq)} + 7\text{H}_2\text{O}_{(l)}$   
D.  $6\text{Ag}_{(s)} + \text{Cr}_2\text{O}_7^{2-}_{(aq)} + 14\text{H}^+_{(aq)} \rightarrow 6\text{Ag}^+_{(aq)} + 2\text{Cr}^{3+}_{(aq)} + 7\text{H}_2\text{O}_{(l)}$
- 

### Numerical Response

6. If the reduction of  $\text{H}_2\text{O}_{(l)}$  had been chosen as the standard reference half-cell reaction, the  $E^\circ$  value for  $2\text{H}^+_{(aq)} + 2\text{e}^- \rightarrow \text{H}_{2(g)}$ , would be \_\_\_\_\_ V.

(Record your answer to three digits on the answer sheet.)

Use the following information to answer the next question.



18. A spontaneous reaction would occur in test tubes
- A. I and III
  - B. I and V
  - C. II and V
  - D. III and IV
- 
19. Hydrochloric acid may safely be stored in a container made of
- A. gold
  - B. zinc
  - C. lead
  - D. magnesium
20. The concentration of  $\text{Sn}^{2+}_{(aq)}$  ions in a solution could be determined most quickly and easily by performing
- A. a redox titration
  - B. a calorimetry experiment
  - C. an acid–base titration
  - D. a precipitation reaction



Use the following information to answer the next question.

**Properties**

- 1 Reacts spontaneously with  $\text{Cu}^{2+}_{(aq)}$
- 2 Reacts spontaneously with  $\text{Cl}^{-}_{(aq)}$
- 3 Is an oxidizing and reducing agent
- 4 Is reduced by hydrogen gas
- 5 Reacts spontaneously with  $\text{H}_2\text{O}_{(l)}$
- 6 Reacts spontaneously with  $\text{Ag}_{(s)}$
- 7 Is an inert electrode

**Numerical Response**

7. Match each of the following species with its **most** appropriate property.

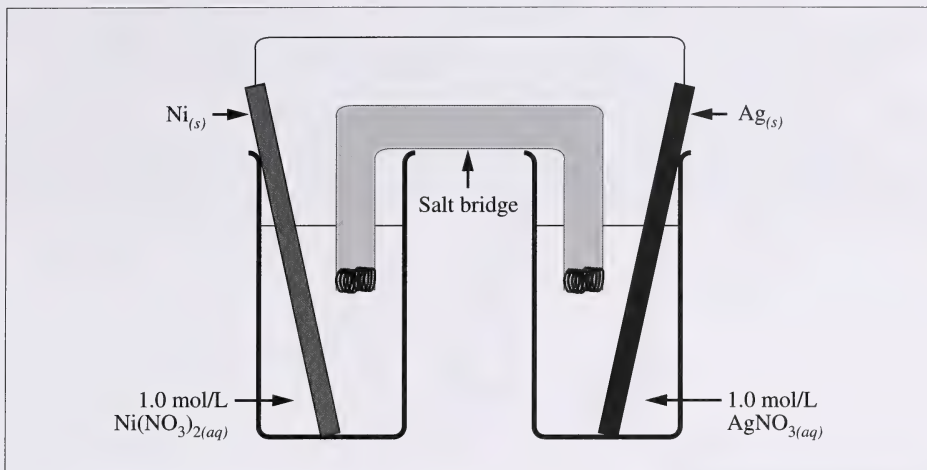
$\text{H}_2\text{O}_{(l)}$  \_\_\_\_\_ (Record in column 1)

$\text{Zn}_{(s)}$  \_\_\_\_\_ (Record in column 2)

$\text{Sn}^{4+}_{(aq)}$  \_\_\_\_\_ (Record in column 3)

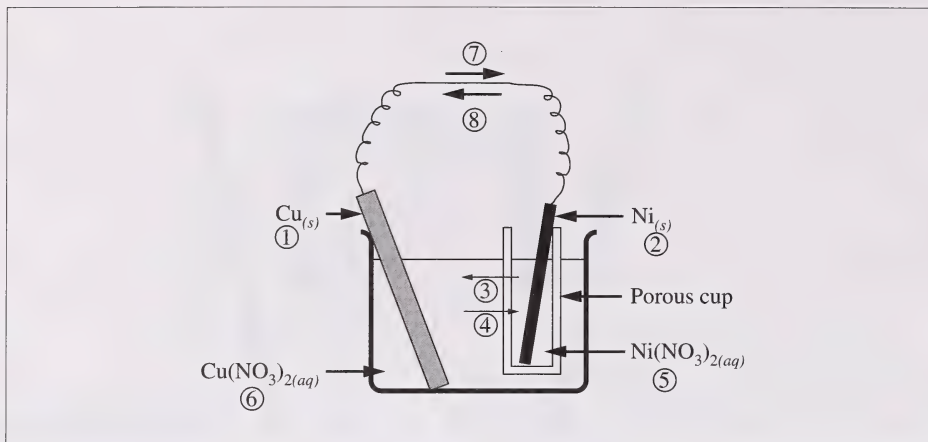
$\text{C}_{(s)}$  \_\_\_\_\_ (Record in column 4)

Use the following information to answer the next question.



21. What would be the effect of replacing the  $\text{Ni}_{(s)}/\text{Ni}^{2+}_{(aq)}$  half-cell with a  $\text{Zn}_{(s)}/\text{Zn}^{2+}_{(aq)}$  half-cell with the same solution concentration?
- A. The  $\text{Ag}_{(s)}$  would change from anode to cathode.
  - B. The  $\text{Ag}_{(s)}$  would change from cathode to anode.
  - C. The  $E^\circ_{\text{net}}$  of the cell would increase.
  - D. The direction of current flow would reverse.

Use the following information to answer the next question.



### Numerical Response

8. Select the correct numbers from the above cell that represent the

cathode \_\_\_\_\_ (Record in column 1)

anode \_\_\_\_\_ (Record in column 2)

electron flow \_\_\_\_\_ (Record in column 3)

anion flow \_\_\_\_\_ (Record in column 4)

Use the following information to answer the next question.

Reactions	Key
$A_{2(aq)} + 2B^{-}(aq) \rightarrow B_{2(aq)} + 2A^{-}(aq)$	1 $A_{2(aq)}$
$C_{2(aq)} + 2B^{-}(aq) \rightarrow \text{no reaction}$	2 $B_{2(aq)}$
$D_{2(aq)} + 2A^{-}(aq) \rightarrow 2D^{-}(aq) + A_{2(aq)}$	3 $C_{2(aq)}$
	4 $D_{2(aq)}$

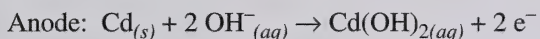
### Numerical Response

9. When these elements are arranged in order from the strongest oxidizing agent to the weakest oxidizing agent, the order is \_\_\_\_\_.

(Record all four digits of your answer on the answer sheet.)

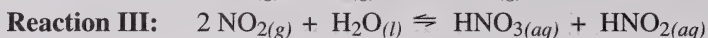
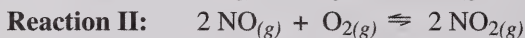
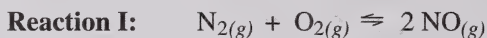


A nickel-cadmium, or NiCad, battery has a long active-life and a long shelf-life but is more expensive to produce than an alkaline battery. The discharging battery has an electrical potential of 1.20 V. The pertinent half-reactions are:



22. The reduction potential for  $\text{Cd}(\text{OH})_{2(aq)} + 2 \text{e}^{-} \rightarrow \text{Cd}_{(s)} + 2 \text{OH}^{-}_{(aq)}$  is
- A.  $-1.69 \text{ V}$
  - B.  $+0.09 \text{ V}$
  - C.  $+0.71 \text{ V}$
  - D.  $+1.69 \text{ V}$
23. In the discharging battery,
- A. the  $E^{\circ}_{\text{net}}$  is positive
  - B. oxidation occurs at the cathode
  - C. electrons flow from the cathode to the anode
  - D. anions are attracted to the cathode
24. The discharging battery will operate for 9.00 h at 0.500 A before it needs to be recharged. The mass of cadmium consumed is
- A. 18.9 g
  - B. 9.44 g
  - C. 5.24 mg
  - D. 2.62 mg

In a car engine,  $\text{NO}_{(g)}$  can form. Once released into the air,  $\text{NO}_{(g)}$  can react with oxygen and water to produce acid rain.



### Numerical Response

10. The oxidation numbers for nitrogen in the order given are

$\text{N}_{2(g)}$  \_\_\_\_\_ (Record in column 1)

$\text{NO}_{2(g)}$  \_\_\_\_\_ (Record in column 2)

$\text{HNO}_{3(aq)}$  \_\_\_\_\_ (Record in column 3)

$\text{HNO}_{2(aq)}$  \_\_\_\_\_ (Record in column 4)

25. The equilibrium expression for reaction II is

A.  $K_{\text{eq}} = \frac{2[\text{NO}_{(g)}][\text{O}_{2(g)}]}{2[\text{NO}_{2(g)}]}$

B.  $K_{\text{eq}} = \frac{[\text{NO}_{(g)}]^2 [\text{O}_{2(g)}]}{[\text{NO}_{2(g)}]^2}$

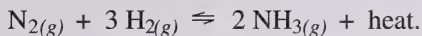
C.  $K_{\text{eq}} = \frac{2[\text{NO}_{2(g)}]^2}{[\text{NO}_{(g)}]^2 [\text{O}_{2(g)}]^2}$

D.  $K_{\text{eq}} = \frac{[\text{NO}_{2(g)}]^2}{[\text{NO}_{(g)}]^2 [\text{O}_{2(g)}]}$

26. A student knows that as more  $\text{NO}_{(g)}$  is produced in the endothermic reaction I, more acid rain forms as a result of reaction III. If the temperature of a car engine is increased, the amount of  $\text{HNO}_{3(aq)}$  and  $\text{HNO}_{2(aq)}$  produced in reaction III will

- A. decrease because the reaction I equilibrium shifts to the left
- B. decrease because the reaction I equilibrium shifts to the right
- C. increase because the reaction I equilibrium shifts to the left
- D. increase because the reaction I equilibrium shifts to the right

Fritz Haber was awarded the Nobel Prize in 1918 for his development of a process capable of synthesizing ammonia. The Haber process involves injecting hydrogen and nitrogen into a heated reaction vessel. The overall reaction involved is



### Numerical Response

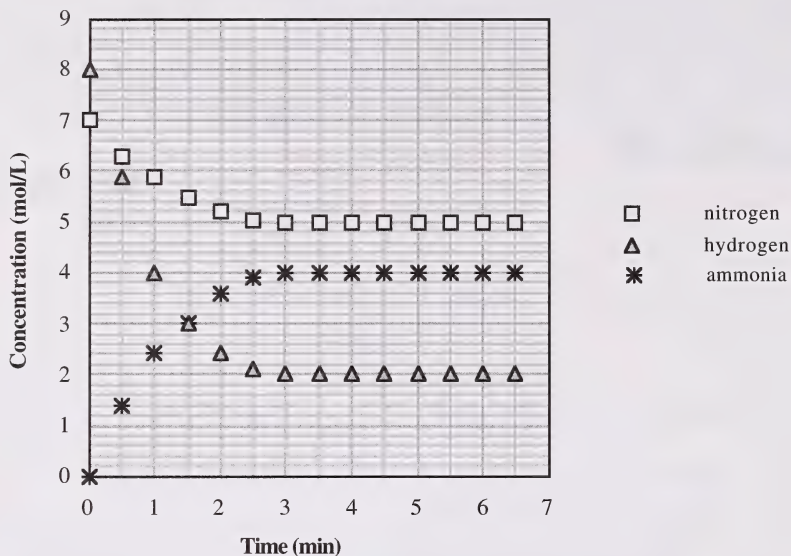
- 11.** The heat of reaction for the production of ammonia shown above is \_\_\_\_\_ kJ.

(Record your answer to three digits on the answer sheet.)

- 27.** This reaction is an example of an
- A.** exothermic redox reaction
  - B.** endothermic redox reaction
  - C.** exothermic neutralization reaction
  - D.** endothermic neutralization reaction

Use the following information to answer the next two questions.

An experiment designed to investigate this reaction yielded the data plotted below.



28. At what time was equilibrium first reached in this experiment?

- A. 0.0 min
- B. 1.5 min
- C. 3.0 min
- D. 6.5 min

Use the value selected for *Multiple Choice 28* to answer *Numerical Response 12*.

**Numerical Response**

12. The  $K_{eq}$  for this reaction is \_\_\_\_\_.

(Record your answer to three digits on the answer sheet.)



29. The value of the equilibrium constant for this system will change if the system is subjected to a change in
- A. volume
  - B. pressure
  - C. temperature
  - D. concentration
30. Household ammonia is a cleaning product in which the concentration of ammonia is about 2 mol/L. The pOH of a 2 mol/L ammonia solution is
- A. 2.2
  - B. 4.5
  - C. 9.5
  - D. 11.8
- 
31. Which of the following is a correct statement concerning an aqueous solution?
- A. As  $[\text{H}_3\text{O}^+_{(aq)}]$  increases,  $[\text{OH}^-_{(aq)}]$  decreases.
  - B. As  $[\text{H}_3\text{O}^+_{(aq)}]$  increases,  $[\text{OH}^-_{(aq)}]$  increases.
  - C. As pH increases,  $[\text{OH}^-_{(aq)}]$  decreases.
  - D. As pH increases,  $[\text{H}_3\text{O}^+_{(aq)}]$  increases.
32. The  $K_b$  value for the conjugate base of hypochlorous acid is
- A.  $2.9 \times 10^{-6}$
  - B.  $3.4 \times 10^{-7}$
  - C.  $6.8 \times 10^{-8}$
  - D.  $7.1 \times 10^{-9}$
33. The value for  $K_w$
- A. is equal to the  $[\text{H}_3\text{O}^+_{(aq)}][\text{OH}^-_{(aq)}]$
  - B. changes depending on the pH
  - C. shows that adding  $\text{OH}^-_{(aq)}$  increases the  $[\text{H}_3\text{O}^+_{(aq)}]$
  - D. shows that the  $[\text{OH}^-_{(aq)}]$  can never be less than  $1.00 \times 10^{-14}$  mol/L

34. A 0.100 mol/L unknown acid solution is found to have a  $[\text{H}_3\text{O}^+_{(aq)}]$  equal to 0.0015 mol/L. The pH of this acid solution is
- A. 1.00
  - B. 2.82
  - C. 3.82
  - D. 13.00

*Use the following information to answer the next question.*

A substance may be classified as:

- I. an acid
- II. a base
- III. an oxidizing agent
- IV. a reducing agent

35. According to redox theory and Brønsted-Lowry theory, water can be classified as
- A. I and III only
  - B. II and III only
  - C. I and IV only
  - D. I, II, III, and IV
- 

36. The conjugate acid of  $\text{H}_2\text{BO}_3^-_{(aq)}$  is

- A.  $\text{HBO}_3^{2-}_{(aq)}$
- B.  $\text{BO}_3^{3-}_{(aq)}$
- C.  $\text{H}_2\text{O}_{(l)}$
- D.  $\text{H}_3\text{BO}_{3(aq)}$

37. The hydrogen sulphide ion,  $\text{HS}^-_{(aq)}$ , is
- A. the conjugate acid of hydrosulphuric acid
  - B. an amphoteric/amphiprotic species
  - C. a weak acid and a strong base
  - D. a proton donor only
38. Equal volumes of two solutions that contain equal concentrations of  $\text{HCO}_3^-_{(aq)}$  and  $\text{H}_2\text{PO}_4^-_{(aq)}$  are mixed. In the reaction between  $\text{H}_2\text{PO}_4^-_{(aq)}$  and  $\text{HCO}_3^-_{(aq)}$ , the substance that acts primarily as an acid is
- A.  $\text{H}_2\text{PO}_4^-_{(aq)}$
  - B.  $\text{HCO}_3^-_{(aq)}$
  - C.  $\text{HPO}_4^{2-}_{(aq)}$
  - D.  $\text{H}_2\text{O}_{(l)}$
39. The **first equilibrium** established when phosphoric acid ionizes in water is
- A.  $\text{H}_3\text{PO}_{4(aq)} + 3 \text{H}_2\text{O}_{(l)} \rightleftharpoons 3 \text{H}_3\text{O}^+_{(aq)} + \text{PO}_4^{3-}_{(aq)}$
  - B.  $\text{H}_3\text{PO}_{4(aq)} + \text{H}_2\text{O}_{(l)} \rightleftharpoons \text{H}_2\text{PO}_4^-_{(aq)} + \text{H}_3\text{O}^+_{(aq)}$
  - C.  $\text{H}_3\text{PO}_{4(aq)} + 2 \text{H}_2\text{O}_{(l)} \rightleftharpoons \text{HPO}_4^{2-}_{(aq)} + 2 \text{H}_3\text{O}^+_{(aq)}$
  - D.  $\text{H}_3\text{PO}_{4(aq)} \rightleftharpoons 3 \text{H}^+_{(aq)} + \text{PO}_4^{3-}_{(aq)}$

Use the following information to answer the next question.

Acid	$K_a$
$H_2O_{(l)}$	$1 \times 10^{-14}$
$H_2S_{(aq)}$	$1.1 \times 10^{-7}$
$H_2Se_{(aq)}$	$1.7 \times 10^{-4}$

40. The predicted  $K_a$  value of  $H_2Te_{(aq)}$  would be
- A. less than the  $K_a$  for  $H_2O_{(l)}$
  - B. greater than the  $K_a$  for  $H_2O_{(l)}$  but less than the  $K_a$  for  $H_2S_{(aq)}$
  - C. greater than the  $K_a$  for  $H_2S_{(aq)}$  but less than the  $K_a$  for  $H_2Se_{(aq)}$
  - D. greater than the  $K_a$  for  $H_2Se_{(aq)}$
- 

41. In which 0.10 mol/L solution would bromothymol blue turn green?
- A.  $NaOH_{(aq)}$
  - B.  $K_2CO_{3(aq)}$
  - C.  $NaCl_{(aq)}$
  - D.  $HOOC-COOH_{(aq)}$

Use the following information to answer the next question.

Indicator	Colour in Unidentified Solution
orange IV	yellow
methyl red	orange
phenol red	yellow
phenolphthalein	colourless

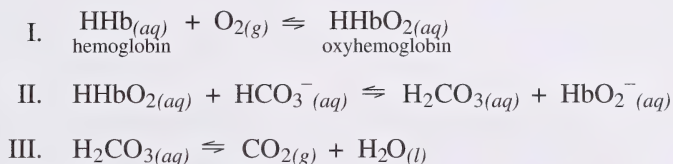
42. The pH of the unidentified solution is approximately
- A. 3.0
  - B. 5.2
  - C. 6.2
  - D. 8.0



43. In a titration experiment, a student finds that 14.00 mL of  $\text{NaOH}_{(aq)}$  are required to neutralize 0.93 g of monoprotic potassium hydrogen phthalate,  $\text{KHC}_8\text{H}_4\text{O}_4(s)$ . The concentration of the base is
- A. 0.00033 mol/L  
B. 0.064 mol/L  
C. 0.33 mol/L  
D. 3.1 mol/L

*Use the following information to answer the next question.*

The control of blood pH is important to the transport and delivery of oxygen in the bloodstream. Some important reactions that occur in the circulatory system are:



Each of these reactions can affect the others.

44. When there is a high concentration of  $\text{O}_{2(g)}$  in the lungs, the effect would be to shift
- A. reaction I right and reaction II left  
B. reaction I right and reaction III left  
C. all three reactions left  
D. all three reactions right

<b>Written Response — 15% (12 marks)</b>
--

- |           |   |
|-----------|---|
| <b>1.</b> | <b>a.</b> Draw a diagram of an electrolytic cell and label it completely. |
|-----------|---|

*Continued*

- b.** Name one industry that utilizes electrolysis. Identify its product(s). Include relevant equation(s).
- c.** State one concern about the operation of the electrolytic cell used by the industry you selected in “b,” and explain why it is a concern.

**Written Response — 15% (12 marks)**

- 2.** Describe a procedure that would allow you to determine if an unidentified 0.100 mol/L acid is monoprotic or polyprotic. You have available standard laboratory equipment and a range of reagents. Describe the relevant results that would help you decide whether the sample is monoprotic or polyprotic.

*You have now completed the examination.  
If you have time, you may wish to check your answers.*



*No marks will be given for work done on this page.*

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*No marks will be given for work done on this page.*

*Fold and tear along perforation.*





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